Prospects of High Angular Resolution Terahertz Astronomy from Antarctica

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Based on atmospheric transmission spectra measured using Fourier transform spectrometer from Dome A, Antarctica [1], prospects of terahertz astronomy through atmospheric windows are discussed. Special focus is on high angular resolution observations which are not easy to realize using space telescopes. High altitude sites in Antarctica provide rare opportunities to observe terahertz sources with large THz telescopes and interferometers.

Figure 1 shows an example of the measured atmospheric transmission spectrum from Dome A, which is one of the best transmittances measured at 12-18h UTC on August 9th, 2010 [2]. When compared with the Atacama site at 5000 m altitude, supra-THz windows from 1 to 1.5 THz are transparent more than twice.

Terahertz astronomy from Antarctica with high angular resolution are of interests, especially for atomic emission lines at 1.46 THz from [NII], 3.4 and 5.8 THz from [OIII] and a water ice feature at 7 THz from protoplanetary disks.

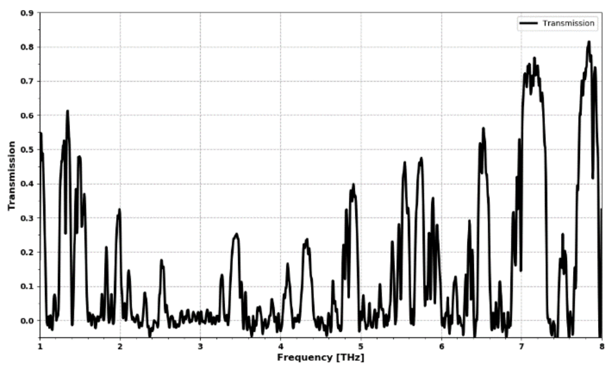

Fig. 1. Atmospheric transmission spectrum measured with Fourier transform spectrometer in Dome A, Antarctica [2].

To achieve high angular resolution, either large single dish telescopes such as DATE5 and THz interferometers will be used. Angular resolution better than 1 arcsecond will resolve many catalogued far-infrared sources; active galaxies, massive star-forming regions, late-type stars and protoplanetary disks. With angular resolution better than 10 milli-arcsecond exceeding ALMA resolution, you can image broad-line region in AGN, late-type stars and inner region of protoplanetary disks.

There are several options for interferometer technologies, such as heterodyne interferometry, Michelson-type beam combining interferometry, Fizeau-type image plane interferometry and Hanbury-Brown and Twiss intensity interferometry. For ease of installation on independent telescopes, heterodyne and intensity interferometry is discussed. The heterodyne interferometry such as ALMA uses SIS mixers in submillimeter frequencies and cross correlation analysis is made on electric fields. The intensity interferometry uses fast detectors, including SIS mixers, and cross correlation analysis is made on intensity (electric field squared). The intensity interferometry can use fast direct detectors such is discussed in Ezawa et al. [3]. The direct detectors do not suffer quantum limited receiver noise, but atmospheric noise dominates for ground-based observations. The difference of heterodyne and intensity interferometry is their dependence on phase fluctuation. The correlation on electric field requires higher phase stability compared with intensity interferometry. The correlation on intensity is stable but requires longer integration for a delay time calibration. Imaging array with direct detector is relatively easy to install. We will be discussing early installation of heterodyne interferometry and later with fast direct detectors for THz interferometry in Antarctica.

References

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